# THE OPERATIVE TREATMENT OF HEAD INJURIES[1].

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THE operative treatment of head injuries, particularly at this time when so much is being done in the way of brain surgery makes the subject, worthy of our careful consideration.

Valuable pathological facts have been learned in many of the operative brain cases; in some, showing the lesion to be due directly to an old head injury, while in others, indirectly the result of such an injury. The head injuries which, in my judgment, demand operative treatment, may be classified as follows:

1. Injuries of the scalp.
2. Injuries of the cranium.
3. Injuries of the contents of the cranium.

Of the first classification I will simply say, that the treatment of these injuries does not differ from the treatment of similar conditions in the soft parts elsewhere with the exception of contusions, in the management of which I make a wide difference, to this effect, when the contusion is accompanied by brain symptoms I expose the part of the skull underlying it by an incision. If there is a depressed fracture I trephine; if there is a fissured fracture with hæmorrhage through the line or lines of fracture I also trephine for reasons which I will mention later.

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I have had ample opportunity in my hospital practice to demonstrate why I take this position in the treatment of contusion of the scalp with brain symptoms. In the large majority of these cases it is impossible to differentiate between simple contusion and contusion associated with depressed fracture, yet the benefit of the doubt is so important to the patient, both as to the immediate and the remote good to be derived from positively settling the question without delay, that I am fully convinced the only sure way is the one which I both practice and advise. Again, in fissured or stellate fracture with swelling, fullness or contusion of the scalp, how is it possible to tell whether the extravasation into the scalp tissue is the result of rupture of the scalp vessels or of leakage from an intra-cranial hæmorrhage, through the fissure or fissures into the areolar tissue layer of the scalp, thus simulating a contusion so closely as to make it impossible to determine the condition in any other way? I grant that by an incision if there be a fracture present, it is made compound, but with our present manner of operating this does not offer a single complication much less an objection.

Compare the old manner of treating these conditions with the relief of a depressed fragment or fragments of bone, the removal of an intra-cranial clot or may be the arrest of an intra-cranial hæmorrhage and, are you not at once convinced my stand is a rational and not a fanciful one.

I have stated I have demonstrated this to be the correct treatment. Naturally the question will be asked, how have I demonstrated it. By making post-mortem examinations in fatal cases, I either did not or was refused the privilege of ante-mortem examination in. In my earlier career as a hospital surgeon, following the instruction I received as a student, I regarded cases of the kind, about which I am speaking, as unjustifiable for operation, believing them to be contusions complicated by concussion or compression. Later, when more attention was being given to cerebral localization I determined it was high time to take nothing for granted, but in the cases terminating fatally, where possible, to learn the actual cause of death by post-mortem examination. This I have rigidly done in a number of cases which I have had under my care in the

hospitals to which I am one of the visiting surgeons. In many of the cases I found either a depressed fracture, a fissured fracture alone, or a fissured fracture with one or more of the varieties of intra-cranial hæmorrhage to which I will refer later and therefore I believe I have good reasons for formulating a rule to be observed in the treatment of these cases to which I now strictly adhere.

The diagnosis of laceration and contusion of the brain substance in fatal cases where an opportunity of inspecting the brain before or after death has not offered, will not stand the scientific test.

Having operated upon a number of old fractures of the skull for epilepsy, brain cyst, arterio-venous aneurism, etc., I am still further convinced that a positive diagnosis should be made immediatly after the receipt of the injury.

Non recognition of a depressed fracture owing to the presence of a contusion of the scalp may arise in a medico-legal point of view, when the patient is afterward the subject of traumatic epilepsy, mental defect, etc.

*Injuries of the cranium.*—The operative treatment of fracture of the skull is practically embraced under one operation, that of trephining; The opinions of different operators are still at variance as to what circumstances render the operation justifiable in certain cases. I will not attempt to give the different views of the authorities upon this subject but, content myself by discussing it from the standpoint I believe to be the safest for the patient, that which I would want done in the case of myself were I so unfortunate as to meet with this accident.

The following list embraces the fractures of the skull in which I advise trephining.

1. Simple depressed fracture with or without brain symptoms.

2. Compound depressed fracture with or without brain symptoms.

3. Impacted fracture, simple or compound, with or without brain symptoms.

4. Comminuted fracture, simple or compound with or without brain symptoms.

5. Compound fissured fracture with depression of bone without brain symptoms.

6. Compound fissured fracture with depression of bone with brain symptoms.

7. Compound fissured fractures without depression of bone and without brain symptoms in which there is bleeding through the fissure or fissures.

8. All punctured, incised and gunshot fractures.

In punctured fractures of the cribiform plate of the ethmoid bone the best point to apply the trephine is to the roof of the orbit at the inner angle, thus opening the most dependent part of the anterior cerebral fossa, thereby favoring drainage, at the same time making it possible to render the parts more thoroughly aseptic; two important indications are to be fulfilled in this class of injuries.

The rationale of trephining in any case of depressed fracture, simple or compound, is that the patient is much less exposed to the risk of becoming the subject of epilepsy, mental defect, persistent loss of memory, general nervous deterioration, to say nothing of the immediate danger of pachymeningitis (external or internal) being excited by the depressed fragment.

I have spoken of the rationale of trephining depressed fractures, my reasons for operating here hold good also for impacted and comminuted fractures, as it is scarcely to be expected that either of the latter varieties can exist without some depression.

My argument for operating in compound fissured fractures without depression of bone, but with brain symptoms, is to determine definitely whether or not they are caused by the presence of a blood clot.

I admit that in the majority of fissured fractures, simple or compound, the fracture extends to and involves the base of cranium, but this I do not regard as a contraindication to exploration, as the association of the two conditions, namely, the presence of the intra-cranial hæmorrhage, and a fracture involving the base of the skull, make the case all the more urgent and less likely to recover if left alone.

All fractures of the base of the cranium, when treated anti-

septically, are not necessarily fatal, as has been shown by Prof. Dennis; therefore, if such a fracture be complicated by the presence of an intra-cranial hæmorrhage conveniently situated for operation, why not here, as in compound fracture elsewhere, remove at once, as far as possible, the complication? With the full benefit of antiseptic surgery this, like many other operations, is attended by little risk in itself, granting, of course, one of the large sinuses is not opened.

If one of the sinuses be accidentally opened in trephining, and the opening be a small one, the bleeding can be readily controlled by grasping the wall of the sinus upon either side of the opening with a hæmostatic forcep, which latter may be left in the wound for two or more days; this is safer than to attempt to control the hæmorrhage by applying a ligature. Should the forceps be in the way of the operator, plug the opening with antiseptic gauze, the latter being always preferable when the opening is large. If we are careful this accident can usually be avoided.

*Injuries of the contents of the cranium.*—Injuries of the contents of the cranium include intra-cranial hæmorrhage and laceration of the brain and its membranes. The treatment of the latter consists chiefly in the removal of foreign bodies, if they be present, rendering the parts thoroughly aseptic, and suturing the dura mater. The treatment of intra-cranial hæmorrhage calls for trephining and removal of the clot. The varieties of intra-cranial hæmorrhage offering the best outlook for good results from operation are the epi (extra) dural and the sub-dural. Intra-cranial hæmorrhage embraces in all four varieties.

1. Where the blood finds its way between the inner wall of the cranium and dura mater.
2. Where it finds its way into the sub-dural space.
3. Where it finds its way into the meshes of the pia-mater.
4. Where it escapes into the substance of the brain or into the ventricles.

Erichsen gives the third variety as the most common form of intra-cranial hæmorrhage, while Prescott Hewett gives the second variety as the most common. (The cases I here report in which I trephined were of the extra and sub-dural varieties).

When blood is poured out between the dura mater and the bone, in case of fracture, the vessel usually torn is the middle meningeal artery or its branches. Mr. Jacobson has shown that the branches of this artery are more frequently torn at the point where it crosses the inferior angle of the parietal bone. The reasons for this are :

1. The bone at the site of the groove for the artery is very thin.

2. The vessel is so frequently buried in the bone that fracture without laceration of the vessel is hardly possible.

3. This part of the skull is especially liable to be broken.

It has been shown that the artery may be ruptured by force sufficient to occasion detachment of the dura mater, but not great enough to fracture the skull. Next to the middle meningeal, the most frequent source of extra-dural hæmorrhage is the lateral sinus. In referring to the attachment of the dura mater to the cranium, we find that it is intimately adherent to the bones forming the base of the skull; therefore, this variety of hæmorrhage in this situation is barely possible. Over the vault of the cranium its attachments are comparatively loose, except along the lines of the sutures. Sir C. Bell has shown that the dura mater of the vault may be separated from the bone by the vibration produced by a blow. Strike the skull of the subject with a heavy mallet; on dissecting you find the dura mater separated from the skull at the point struck. Repeat the experiment on another subject and inject the head minutely with size injection, and you will find a clot of injection lying between the skull and the dura mater at the part struck and having an exact resemblance to the coagulum found after violent blows on the head. Tillaux has demonstrated that the adhesions between the dura mater and the bone are particularly weak in the temporal fossa, the most usual site of meningeal hæmorrhage.

In the diagnosis of extra-dural hæmorrhage the following points are to observed :

*Mental condition.*—May be normal or there may be cerebral irritation. Unconsciousness complete or incomplete or coma.

*Condition of the pupils.*—May both respond to light normally. May both be dilated and show no response ; or one

may be widely dilated and the other normal. When the dilated pupil corresponds to the injured side, it is caused, as pointed out by Hutchinson, by the pressure of a large clot, extending deeply down into the base of the skull on the cavernous sinus, leading to fullness of the vessels with protrusion of the eyeball and dilatation of the pupil. It is also accounted for by the compression of the oculo-motor nerve by the clot.

*Respiration.*—May have stertorous breathing, Cheyne-Stokes respiration or cyanosis.

*Pulse.*—Little changed, or rapid and feeble, depending largely on the severity of the concussion; or slow and full, depending upon the severity of the compression.

*Limbs.*—May present any of the following conditions: Hemiplegia, on the same side as the injury, indicating hæmorrhage on the opposite side; monoplegia, paralysis, twitching, convulsions, rigidity (spastic).

*Scalp.*—Presence of contusion, or bogginess due to the injury; the latter also due to leakage from within the cranium through a fissured fracture.

The stages presented by a typical case of extra-dural hæmorrhage are three:

1. Complete or partial unconsciousness, the result of the concussion or shock, caused by the fall or blow, as the case may be.

2. Consciousness or lucidity. This stage may vary in length from a few minutes to several hours. "Is present in about one-half of the cases," says Jacobson.

A very large hæmorrhage may produce compression at once, as I have observed, verifying my observation by post-mortem examination. Compression may also come on immediately, caused by co-existing depression of bone, injury to the brain, and alcoholism.

3. Compression.

CASE I.—Traumatic aphasia caused by pistol shot wound of the left temporal region with fracture of the internal table of the skull and extra dural clot at a point two inches behind the external angular process of the frontal bone and two inches above the zygomatic arch; trephined; clot removed; anterior branch of the middle meningeal artery tied; perfect recovery.

CASE II.—Lacerated wound of scalp immediately in front of left parietal eminence.

Patient was conscious for a short period after the occurrence of the accident; this was followed by cerebral irritation with twitching of right face, arm and leg. Coma supervened with general convulsions commencing on right side. Skull intact. Trephined. Large extra dural clot involving the region of the posterior ends of the second and third frontal convolutions removed, leaving a space between the skull and the dura mater which held four ounces of a 1:2000 solution of bichloride of mercury. Death two hours after operation.

Autopsy twelve hours after death, brain and cranial cavity alone examined. Upon removal of the calvarium the surface of the dura mater was found normal, except at the point of separation already referred to. Brain removed. Dura mater lining sides and base of skull removed, when was seen a fissured fracture starting in the left parietal bone immediately below trephine opening and extending into the floor of the middle cerebral fossa. Examination of the brain showed it to be perfectly normal except at three points on the basilar aspect of the left temporo-sphenoidal lobe, which were contusions involving only the gray matter, as shown by making sections of the brain. No further evidence of intra-cranial hæmorrhage or other lesion.

CASE III.—Contusion of scalp over vertex and whole of the left side. Lacerated wound of right ear at the junction of the concha with the scalp. Complete unconsciousness; pupils responded to light; conjunctival reflexes normal. A short period after the accident regained consciousness lasting about five minutes, which was followed by a general epileptiform convulsion lasting one minute. Convulsion commenced on right side. This was followed by a second convulsion of the same character. Right arm and leg spastic. Left arm and leg parietic. Trephined over the anterior branch of the left middle meningeal artery. Extensive sub-aponeurotic hæmorrhage. Fissured fracture Extra dural hæmorrhage, both the posterior branches of the middle meningeal artery torn. Clot removed and vessels tied.

CASE IV.—Swelling of the right side of scalp with sub-conjunctival ecchymosis of right eye. Scalp tumor incised, finding fracture of the right parietal bone. Trephined. Extra dural clot. Meningeal vessels tied. Death two and one-half hours after operation. No autopsy.

CASE V.—Compound depressed fracture of the skull in left temporal region. Trephined. Bleeding meningeal vessels tied. The fracture was plainly seen extending into the petrous portion of the temporal bone. Death four hours after operation. No autopsy.

CASE VI.—Unconsciousness. No paralysis, patient able to swallow.

Small scalp wound over the occipital region. No operation. Death in forty-eight hours.

Autopsy, fissured fracture of the occipital bone extending from the external occipital protuberance into the foramen magnum. Extensive sub-dural hæmorrhage.

CASE VII.—Struck by a train. Unconscious. Stertorous breathing. Right hemiplegia. Large scalp wounds. Depressed fracture over left parietal bone. Trephined and fragments of bone removed one-half hour after operation; consciousness returned and uninterrupted recovery followed.

CASE VIII.—Swelling of scalp over left temporal bone which increased in size. Unconsciousness. No paralysis. Operation refused. Death in thirty six hours.

Autopsy twelve hours after death. Fracture of the left temporal bone extending into middle fossa of skull. Large extra-dural clot. Brain normal.

CASE IX.—Small scalp wound over vertex with a bulging tumor in the left temporal region. Ecchymosis of the left upper eyelid with a small tear of conjunctiva. No subconjunctival ecchymosis. I enlarged the wound and found a sub aponeurotic collection of blood with a fissured fracture involving the temporal bone. Trephined. Ligated the anterior branch of the middle meningeal artery. Found the dura bulging presenting a bluish appearance. I incised the dura and found a large clot of blood occupying the sub-dural space. This was removed and the cavity containing it flushed with an antiseptic solution. Dura stitched and scalp wound closed. Death one and one-half hours after the operation.

Autopsy twelve hours after death showed a fissured fracture extending through the temporal bone into the middle cerebral fossa. Brain intact. Sections of brain showed ventricles empty and the absence of contusion or ecchymosis. I believe the immediate cause of death was due to the intra cranial bleeding, therefore had the patient been operated upon immediately after the receipt of the injury his chances for recovery would certainly have been much better. This case most beautifully demonstrates the correctness of my views regarding trephining in fractures of this variety, the source of the sub-aponeurotic collection of blood, and how this form of tumor closely simulates a contusion.

The above cases are a few of the many I have seen in my hospital service, but I think they are sufficient to demonstrate clearly the force of my remarks.